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THE PRESENT STATUS OF THE BIOGENETIC LAW[1]

THE biogenetic law or the doctrine of recapitulation not long ago ranked as one of the most important principles of biology. In recent years it has been attacked repeatedly both from the botanical and zoological sides. Since the basal data upon which it is founded have not at any time been called in question and in fact have rather increased in number and importance, as a result of the more recent historical and developmental study both of plants and animals, it becomes a question of interest to discover why this change of attitude has taken place. One of the most important reasons for the momentary eclipse of the doctrine of recapitulation is doubtless the present vogue of the doctrine of mutation. It is distressing apparently to the mutational state of mind to grant that the past history of living beings is an important factor in their present organization. If it be generally true that new species can originate all at once by saltation or sudden change, the past history of such species becomes a matter of less importance and it naturally follows that the possibility of such a past being recorded in their developmental stages becomes highly problematical. As a consequence of this situation we have heard much destructive criticism of the biogenetic law on the part of zoologists of mutational tendencies, such as Montgomery, Morgan and others. It has been asserted, for example, that the gill arches of the mammalian embryo do not indicate, as was previously supposed, an aquatic habit on the part of ancestral forms from which on the basis of paleontological and developmental evidence, the warm-blooded animals have come. It is plausibly suggested that the undoubted presence of gill-arches in the mammalian embryo is an embryonic response to the early aquatic existence in the maternal amniotic fluid. In other words, it is asserted that what the morphologist and the paleontologist explain in terms of the biogenetic law as vestiges of a former state represent merely a larval adaptation, which is of no evolutionary significance. This is substantially the position assumed by Morgan in his "Critique of Evolution," which has recently enjoyed a great vogue.

There is another group of critics of the biogenetic law, whose objections are based too exclusively on a Paleozoic point of view. This group presents an interesting resemblance to those whose training makes

[1] Address delivered by invitation before Section K, British Association for the Advancement of Science, Toronto meeting, August, 1924.

them look at all modern life through the eyes of Greece and Rome. Very often they represent opinions, which, although long received, have by reason of later discoveries ceased to square with the known facts. Obviously it is impossible in a general statement to deal in detail with conscientious objectors of this type.

The higher plants, particularly the Conifers, supply an admirable basis for the examination of the fundamental basis of the biogenetic or recapitulationary law. Since the young of the seedplants is sheltered under uniform conditions throughout, in its embryonic or intraovularial phases, the complications of development known as larval stages in animals do not occur. In this respect, as in so many others, the higher plants show themselves superior to animals for the investigation of general biological principles on the basis of inductive reasoning. In the case of seedplants the process of events is accordingly not obscured or confused by any larval mask so that it is apparently easy, for the open mind at any rate, to interpret the facts of development and history. The situation in the case of plants is further favorable by reason of the many adaptations to actual environment which they have in the course of time been forced as it were to develop, by reason of their sedentary life, which contrasts so strikingly with the generally mobile existence of animals.

A very striking mode of adaptation in the case of plants is found in connection with the growth on a dry soil or one in which the water relations for one reason or another are unfavorable. An excellent illustration of this condition is supplied by the Cactus family. In the genus Peireskia, normal leaves are developed, but many of the other genera are quite leafless except in their early seedling stages, in which they usually develop more or less normal seed-leaves or cotyledons. The genus Cereus is interesting because in some of its species it does not even develop cotyledonary leaves. It is not improbable that related genera, such as Echinocactus, Melocactus, Anhalonium, etc., will prove to be equally without seedleaves or cotyledons. Preliminary investigations carried on in my laboratory show that in a number of these more highly specialized Cactus genera, even the vessels which so uniformly characterize the angiospermous seed-plants are likewise absent. The occurrence of cotyledons in genera of cacti, which are quite without leaves in the adult vegetative condition, can only be interpreted as the occurrence of an ancestral structure in the seedling, which has quite disappeared in the adult; in other words, as an example of the validity of the doctrine of recapitulation.

There are numerous parallel instances among species inhabiting dry or poisonous soil. For example, we have in North America many species of Veronica, in which the leaves have a quite normal development and a very characteristic form. In certain exotic Veronicas the leaves are very small and are confluent with the surface of the stem. In their young condition these xerophytic Veronicas have, however, leaves precisely like other Veronicas. The same condition is exemplified by the nearly leafless Rubus of the "Malle Scrub" of Australia, which in its seedling condition has leaves like other raspberries. Examples of this kind could be multiplied indefinitely and all show clearly that the young of desert plants show organization resembling that found in allied species growing under normal water supply. Since the young are absolutely under the same conditions of environment as the adults, the differences of nepionic or seedling organization are rationally explained as the persistence of a tendency to grow like the ancestral mesophytic forms, from which the xerophytic or desert-inhabiting modifications were originally derived.

The seedlings of plants which have become adapted to a dry or desert habitat accordingly supply an extremely good illustration of the doctrine of recapitulation, since in their first development they manifest peculiarities which are only explainable as the persistence of a tendency to grow like nearly related forms living under more normal conditions of water supply.

Similar conditions are supplied by plants provided with flattened stems or phylloclads or by that abnormal type of leaf known as the phyllode. In their seedlings these forms usually show the type of organization characteristic of the more normal nearly related species or genera. Innumerable similar examples could easily be supplied of angiosperms showing marked adaptations to special conditions of existence in the adult, which go through a normal development in the young state and thus supply evidence in favor of the validity of the doctrine of recapitulation.

We may now advantageously turn our attention to the conifers, a group of very special interest in the present connection on account of their great geological age. Although the group as a whole is evergreen and has obviously been so for many thousands of years, there are deciduous genera such as the larch (Larix) and the Chinese larch (Pseudolarix) which regularly shed their leaves in the autumn. Interestingly enough the seedling of our larches is for a few years evergreen. Since it grows under precisely the same conditions as the adult, this striking deviation in habit can only be explained as a persistence of an ancestral feature, namely, the typical coniferous evergreen habit, in the young individual and at the same time an exemplification of the validity of the biogenetic law. Another of our commonest and at the same time most interesting conifers is the pine. This is characterized by having its leaves attached to the

stem in clustered fascicles, which in modern species are from two to five in number. In the first year's development the leaves occur singly and directly attached to the stem, which is obviously the harking back to an ancestral condition. In many of our higher conifers the leaves are small and more or less confluent with the surface of the stem. This condition, for example, is found in certain junipers, in the arbor vitae, the big tree, the incense cedar, etc. In the seedling all these forms have quite normal free leaves, the presence of which is explainable on the basis of the doctrine of recapitulation. The Japanese umbrella pine, Sciadopitys, which in the adult bears only needles comparable to those of a two-leaved pine, but fused together, in the seedling condition, for a short time, produces normal leaves. In certain conifers now confined to the southern hemisphere and belonging to the genus Phyllocladus, the branches are flattened to resemble leaves and the real foliar organs are rudimentary. In the seedling normal leaves and stems always are present for a time.

All the above illustrations of the exemplification of the doctrine of recapitulation by the conifers have reference to external organization and to living forms. We shall now turn our attention to the important internal structures and to fossil forms. I have devoted a large amount of time to the study of the anatomical organization of extinct conifers belonging to earlier geological times. It will be of interest in this connection to examine how certain well-known living conifers compare anatomically with their extinct ancestors and what basis they supply for the validity of the doctrine of recapitulation. Mention has already been made above of the pines. This genus, as some of you are aware, is a very ancient one, extending back in substantially its present form at least to the middle of the Mesozoic period (Jurassic). In its earliest occurrence Pinus was different in certain notable respects from its living representatives and, like the Cycads, was much more numerously represented by species than it is at the present time. The earliest pines, instead of the two to five needles in a cluster, which are a feature of our existing pines, had numerous leaves in a fascicle. Another interesting feature of these primeval pines was the fact that the wood in the leaf began its growth towards the upper surface of the leaf as is the case in the earliest known gymnosperms. In anatomical structure the wood was different from our living pines, in several respects, only one of which will be mentioned. In our existing species of Pinus, the rays of the wood are accompanied by horizontal tracheids or water-conducting elements. These structures were absent in the earliest pines. Even at the beginning of the Cenozoic, as exemplified by the pines of the Baltic amber deposits, the horizontal or ray tracheids only made their appearance after the branch had grown for a number of years. In the late Mesozoic (Cretaceous) marginal ray tracheids have been found in certain American species, investigated in my laboratory, but their appearance was deferred even later than in the pines of the Baltic amber deposits. In our living pines the tracheids are late in appearing in the seedling, and in the root, which is of all plant organs the most conservative, it is often many years before the ray tracheids make their appearance along the margins of the rays in the wood. In the cone or reproductive axis, which has from two to three annual rings, marginal or ray tracheids are usually quite absent. Dr. A. E. Longley has made some very interesting observations on the effect of injury on the wood of the pine. He has discovered that even in the old stem the wood formed after injury is for several years without the marginal ray tracheids. It will be obvious from the above statements that the oldest pines were entirely without ray tracheids in their wood and that after these structures made their appearance they were at first greatly delayed in the late Mesozoic and less so in the early Cenozoic of the Baltic amber pines. In the adult stem of living pines they appear at once in the first year's growth, but they are delayed in the seedling in accordance with the doctrine of recapitulation. Interesting subsidiary doctrines to that of recapitulation are exemplified by the old and interesting genus Pinus, unquestionably the most ancient surviving tree of our northern forests. In accordance with the doctrine of retention of ancestral conditions in conservative organs, we find a similar delay to that exemplified by the seedling of the pines in the root and cone in the appearance of the marginal tracheids. Further, as a result of injury the formation of marginal tracheids may be inhabited for several years and the structure of the wood thus reverts to the ancient condition of organization.

The doctrine of recapitulation is consequently admirably illustrated by our ancient but still living genus Pinus, as becomes clear from a comparison of its younger organization with that of the extinct species of earlier geological times. Further, the evidence derived from a detailed comparison of root and cone or reproductive axis shows that these two organs likewise present features of resemblance to the seedling stem. In other words, root and stem of the adult are conservative organs. These conditions I have described as illustrative of the doctrine of retention of ancestral structures by conservative organs and in the course of my anatomical investigations on other groups of plants from the Calamites

upwards have found to be of wide validity. This doctrine so far as I am aware has not been developed in the case of animals. A very important general principle is that of reversion to extinct types as a result of injury. This condition exemplified by Pinus is of special importance because the reversionary reaction is often the most persistent indicator of former conditions, since it makes itself felt when all other indications of ancestral organization have become obliterated by time. The comparison of living pines with their extinct forbears of the Mesozoic and Cenozoic periods consequently supplies us with three useful working principles. These are, first, recapitulation, which is clearly and strongly supported by the data supplied by living and extinct pines. Second is the doctrine of retention or the doctrine of conservative organs. Finally, we have the doctrine of reversion as a result of injury.

Time-honored candidates for the position of the primitive surviving coniferous group are the Araucarian conifers, at the present time confined to the southern hemisphere but formerly flourishing side by side with the pine tribe or Abietineae in the northern latitudes. The view that the Araucarians are the most primitive living conifers is based on the comparison of the existing representatives of the stock with the Paleozoic gymnosperms. Such a point of view apparently presents the same disadvantages as does a purely classical training for the solution of the practical problems of modern existence. The Paleozoic is too far away to be compared directly with the Cenozoic, and many gross fallacies have been the result of this impossible comparison.

The Araucarian conifers as at present organized are distinguished by generally broad leaves comparable with the Paleozoic Cordaitales. Further the Araucarians have a type of wood superficially quite comparable with that of the Cordaitales, for, as in that group, the pits or valves of the tracheids alternate and the walls of the tracheids in the mature wood are quite without bars of Sanio. The Abietineae or pine subtribe by contrast has needle-like leaves and the tracheids have opposite pits, and bars of Sanio are present in the radial walls of the tracheids of the secondary wood.

Another ancient surviving group is that of the Ginkgoales with a single living representative, *Ginkgo biloba*. Although it is generally admitted that this is a very ancient group comparable with the most ancient of the conifers, it has the same type of tracheids as Pinus, namely, with opposite pits and bars of Sanio. Like Pinus it has also leaves borne on short shoots. Its reproductive anatomy also closely resembles that of Pinus, since the seeds and microsporangia are both borne in twos on the sporophylls and the megasporophyll has inverted fibrovascular bundles, as is the case with the Abietineae. Ginkgo is likewise provided with winged microspores which not only in this feature but also in their internal organizations are in detailed agreement with the Abietineae. A further interesting coincidence is presented by the mode of opening of the microsporangia, which is through the instrumentality of an internal mechanical layer in intimate connection with the fibrovascular system. This situation is all the more significant because the cycads and other lower gymnosperms as well as the ferns effect the dehiscence of their pollen sacs by the action of an epidermal mechanical layer, the annulus. A final interesting and striking point of resemblance between Ginkgo and the Conifers is the presence of "Rotholz." This reddish hued mechanical tissue is recognized as peculiar to the conifers. It is a most significant coincidence that the Ginkgo should be the only other lower gymnosperm to parallel this feature. It seems beyond question that Ginkgo and the Abietineae, particularly Pinus, their most ancient representative, are very closely related. As a consequence, if Ginkgo is an ancient type, as is universally conceded, the same must hold true for the genus Pinus, on the basis of a detailed anatomical agreement. It is expedient to emphasize the important evidence for the close relationship between the Ginkgoales as a preliminary to the further discussion of the Araucarian conifers and the doctrine of recapitulation.

We may now advantageously examine other characteristics of the surviving representatives of the Araucarian conifers. A very striking feature of the two surviving genera, Agathis and Araucaria, is the persistence of the conducting strands to the leaves long after the leaves themselves have fallen. In trunks a hundred or more years old, the foliar traces may still be found in the outer annual rings in regions corresponding to the fallen leaves, which they formerly supplied with water. No comparable feature is found in any other seedplant, and Professor Seward regards this peculiarity as strong evidence for the antiquity of the Araucarian stock. I am free to confess that I am unable to follow Professor Seward's logic in this conclusion, but I think that I am representing his point of view fairly.

An examination of the seedlings of the two genera Agathis and Araucaria in my laboratory has brought to light the interesting fact that although the leaf-traces persist in the old tree indefinitely they are of very short duration in the seedling, lasting only for a few years. This fact becomes of great importance in connection with the study of the fossil forms. Another interesting feature of the young Araucarian stem as well as of the root and cone-axis is the pres-

ence of wood parenchyma. In the Cordaitales no wood parenchyma ever occurs in the secondary wood, and this holds true for the wood of Paleozoic gymnosperms quite generally. Wood parenchyma is only certainly known to occur in Jurassic and later secondary woods. Perhaps the most interesting feature of the organization of the secondary wood in the Araucarian conifers is the occurrence of opposite pitting and bars of Sanio in its first-formed portion. This condition can not be harmonized with the theory of the cordaitean origin of the Araucarian stock, as is the view generally accepted in Great Britain and Germany. The neglect of comparative anatomy on the part of European paleobotanists seems deplorable because no permanently satisfactory conclusion can be reached without a thorough knowledge of the general anatomical structure of the conifers living and extinct, as well as the general principles of anatomical science as applied to all groups of plants.

A commonly emphasized argument for the Cordaitean origin of the Araucarian conifers is the occurrence of quantities of woods of the Araucarian type in earlier geological deposits. My students and myself have made very extensive examinations of the extremely abundant and varied material from the Mesozoic deposits of North America and have not been able to agree that the common European view in regard to the abundance of woods of the modern Araucarian type in Mesozoic deposits. In all our investigations, which cover material from Texas to Dakota and from Washington to Massachusetts, we have found only two specimens of woods of the type of Agathis and Araucaria. In these rare and isolated fossil woods as in the living genera the leaf-traces are persistent. An interesting difference between the mature stem wood of the true Araucarioxyla described by us and that of the living genera is the presence of abundant wood parenchyma. It has been stated above that on the basis of the anatomical structure of the whole organism in the case of Agathis and Araucaria, they must have come from ancestors with well-developed wood parenchyma, although this is lacking in the mature stem wood of the two living genera. We have accordingly pointed out that the term Araucarioxylon must be used in a restricted sense, in view of the general anatomical conditions in living Araucarians. Its use should be confined to woods with indefinitely persisting leaf-traces and well-developed wood parenchyma. If it be objected that comparative anatomical data are not of value, it may be replied that the zoological paleontologists attach great importance to comparative anatomy and it may further be suggested that much of the slight esteem in which botanical paleobotany is at present held is due to the perhaps unnecessarily wooden manner in which it has been developed. It can not be too strongly emphasized that it is impossible to work out the evolutionary position of extinct plants on the basis of the structure of secondary wood alone. If my European paleobotanical colleagues were to moderate by the light of reason their suspicion of what have recently been called "Phylogenetische Abwege," I feel that the results for the science would be happy. In this respect they might well take example from their zoological fellow-workers who have gained much by profitable excursions along phylogenetical byways.

It has become obvious as the result of the investigations of the past decade and a half that most of the woods that have been described as Araucarioxyla are not woods of forms comparable in any strict sense with our two modern genera, Agathis and Araucaria. By far the greater number of woods of the Cretaceous and Jurassic, which a few years ago were universally included under the form genus Araucarioxylon, do not belong there at all.

Nearly twenty years ago, I described for the first time, in collaboration with Dr. Arthur Hollick of Columbia University, the anatomical structure of the important Mesozoic genus Brachyphyllum, which was recognized at that time to be of Araucarian affinities, although not immediately related to Agathis or Araucaria. With the structurally preserved twigs of Brachyphyllum were fragments of wood which showed the same general organization as did the twigs of Brachyphyllum. Some of my European colleagues have at various times objected to the reference of these woods to affinity with the small twigs of Brachyphyllum. The diagnosis has been confirmed in the interval, however, by splitting out small branches from large fossil trunks. The result of the microscopic comparison of the small twigs with their parent axis have entirely justified the conclusions reached at that time on comparative anatomical grounds.

The wood at first referred to Brachyphyllum was three years later erected into a form genus under the generic appellation of Brachyoxylon. This wood presented a number of interesting features. With Araucarian pitting it united the absence of wood parenchyma, non-persistent foliar traces and the presence of traumatic resin canals. The last three features all marked it off very clearly from Araucarioxylon. I believe that this was the first instance in which it has been pointed out that experimental evidence is important in the case of fossil woods. The wound reactions of coniferous woods are often of great diagnostic importance and their significance is just beginning to be realized by my European colleagues.

It is quite obvious that by far the greater number

of so-called Araucarioxyla previously described on this continent and in Europe in reality belong to the genus Brachyoxylon or allied genera and not to Araucarian conifers of the Agathis or Araucaria type. There is an interesting difference of opinion between American and European paleobotanists as to the interpretation of the results. For some unexplained reason my European colleagues have ignored the important genus Brachyoxylon and have invented other and often inappropriate names for other transitional woods described by my students and myself.

Brachyoxylon differs from Araucarioxylon by the absence of wood parenchyma and by its non-persistent foliar traces, as well as by the wound canals which can always be observed in adequate material. Obviously Agathis and Araucaria have come from ancestors which were without persistent leaf traces, since no wood with continuing traces has been described from the lower Mesozoic. This conclusion is likewise reinforced by the evanescent character of the foliar traces in the seedlings of Araucaria and Agathis. Professor Torrey, working up a large collection of Mesozoic and Cenozoic woods, discovered an interesting genus connecting Brachyoxylon and Araucarioxylon, to which he gave the name Telephragmoxylon. This shows the beginning of the formation of wood parenchyma but has the evanescent leaf-traces and the traumatic canals of Brachyoxylon.

The higher members of the Abietineae, such as for example Cedrus, Abies and Tsuga, are in general without normal ligneous resin canals except in the root. When any of these three genera has its wood injured, traumatic resin canals are formed, vertically only in Tsuga and Abies, but both horizontally and vertically in Cedrus. The rational as well as natural explanation of these conditions is that the three genera in question have come from Pinus by reduction and revert under conditions of injury.

Similarly, in the case of Brachyoxylon we have a reversion of an Araucarian type of wood as a result of injury to a condition, resembling, so far as the wound canals go, that found in Abies or Tsuga. Certainly, if we regard Abies or Tsuga as having come from Pinus, we must consider Brachyoxylon as also of Abietineous origin and derived from an ancestry allied to Pinus.

Both in Araucarioxylon and in the living representatives of the Araucarian conifers, we find opposite pits and bars of Sanio *at the beginning of the secondary wood,* a further feature justifying their derivation from Abietineous origin.

It is out of place at this time to go into the question of the evolution of the conifers further. It will be sufficient to point out in conclusion how completely the situation has changed in the past ten years or more in regard to the relative status of the pine-like and Araucarian conifers. Formerly the Araucarian conifers were regarded as preponderant and the Abietineae of slight importance. In the most recent German treatment of the subject six Mesozoic genera of the "Protopinaceae" are described, including thirty or more species mostly transferred from types formerly considered as Araucarian. As a consequence of this procedure the Abietineae become the predominant conifers of the Mesozoic, and the true Araucarioxyla constitute an insignificant remnant. I personally regard the most of these so-called Protopinaceae as forms which have reached the araucarioid condition from abietineous ancestry. The German paleobotanists arrive at the opposite conclusion. It seems unfortunate from their standpoint that they have now to transfer the greater number of coniferous Mesozoic woods, formerly supposed to be Araucarian, to abietineous affinities.

In any case it is highly probable that the logical use of the biogenetic law will in the future clear up this condition of confusion. When the dust of conflict has settled, it will probably appear that Ginkgo and Pinus stand side by side as the prototypes of Mesozoic gymnosperms of cordaitean derivation. It will then be realized that Agathis and Araucaria are aberrant extremes, which merely simulate Cordaites on the basis of extremes meeting but have no near affinity with them. In any case the thesis of the predominance of the Araucarians, in the Mesozoic, must be abandoned, because, by a *reductio ad absurdum,* the German and some other paleobotanists, by their very zeal to save the time-honored Araucarian thesis, are led to refer most of what were formerly regarded as undoubted Araucarian forms to the Abietineae.

The progress of biology along historical lines lends accordingly new support to the already well-documented doctrine of recapitulation. When the doctrine of mutation is relegated to its relatively unimportant position among biological working hypotheses, the great general significance of the biogenetic law or the doctrine of recapitulation will be clearly recognized.

HARVARD UNIVERSITY EDWARD C. JEFFREY

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE COMMITTEE ON THE PLACE OF THE SCIENCES IN EDUCATION

THE following persons have been appointed on this committee, and others are to be added:

Dr. Edna M. Bailey, supervisor of the teaching of science, University High School, Oakland, California. Representative of high schools.

Dr. Jesse B. Davis, professor of secondary education, Boston University. Representative of secondary education in the municipal university.

Dr. Eugene Davenport, dean and professor emeritus, College of Agriculture, University of Illinois, Woodland, Michigan. Representative of agriculture and rural life.

Dr. E. R. Downing, associate professor of natural science, School of Education, University of Chicago. Representative of university school of education.

Dr. Max Farrand, professor of history, Yale University, New Haven, Connecticut, and chairman of the Educational Committee of the Commonwealth Fund. Representative of social sciences.

Dr. R. C. Gowdy, professor of physics, University of Cincinnati. Representative of physics in the university.

Dr. George W. Hunter, professor of biology, Knox College, Galesburg, Ill. Representative of college science teaching.

Dr. V. E. Kellogg, permanent secretary of the National Research Council. Representative of National Research Council, Washington, D. C.

Dr. Harvey B. Lemon, professor of physics, University of Chicago. Representative of university department of physics.

Dr. Burton E. Livingston, professor of plant physiology, Johns Hopkins University, and secretary A. A. A. S., Washington, D. C. Representative of A. A. A. S.

Dr. C. R. Mann, director, American Council on Education, 26 Jackson Place, Washington, D. C. Representative of national education.

Dr. J. Playfair McMurrich, professor of zoology, University of Toronto. Representative of biology in the university.

Mr. John Mills, personnel director, engineering department, and chairman of the College Relations Committee, Western Electric Company, Inc., New York. Representative of electrical engineering.

Dr. Mary S. Rose, professor of nutrition, Teachers College, New York. Representative of household sciences.

Dr. G. M. Ruch, professor of psychology, University of Iowa. Representative of psychological study of science testing.

Mr. S. D. Shankland, executive secretary, Department of Superintendence of the National Education Association, Washington. Representative of National Education Association, Department of Superintendence.

Dr. Frank L. Wade, head of the department of chemistry, Shortridge High School, Indianapolis, Ind. Representative of high schools.

Dr. H. J. Waters, managing editor, *The Weekly Kansas City Star*, Kansas City, Mo. Representative of the public press, and science needs of rural and city life.

Dr. Hanor A. Webb, professor of chemistry, George Peabody College for Teachers, Nashville, Tenn. Representative of teachers college.

Mr. C. M. Wescott, teacher of physics, Hollywood, Cal. Representative of high schools.

The following outline of topics has been placed before the committee. Committee members and others will doubtless add other topics, and will suggest many changes in the statements here made concerning these topics. The outline here presented is designed to serve as basis for discussions and later written comment to be submitted to the whole committee. It is hoped that small discussion groups may meet in various centers, and as a result of the discussion may formulate and submit their written comments to the chairman of the committee.

Purpose of This Communication

A very important piece of work has been assigned to a committee as shown in the accompanying material. If this committee may have the cooperative efforts of those to whom this communication and later ones are sent, possibly something of value may result. You are asked to read this memorandum and to make constructive suggestions in line with the committee's problems. Please submit suggestions as to opinions, facts or further studies which pertain to the work. If you know of educational studies which bear upon the topic in any way, please bring these to the attention of the committee. In case of each of the organizations of graduate students to whom this memorandum is sent, it is requested that a group conference be held and that a committee of the conference be asked to prepare, and forward to the committee, a report of the suggestions of the conference. Conferences of teachers of science are asked to follow the same procedure.

Purpose and Support of the Committee

At the meeting of the A. A. A. S., held in Cincinnati, December, 1923, a committee was authorized to study the place of sciences in educational curricula. The members of the A. A. A. S. who initiated this committee desired that, with the unprecedented development of the sciences both in research and in everyday use of science knowledge there should be a somewhat clearer and more widely recognized understanding of the functions of the sciences in current educational programs. It may not be possible to construct the desired statement upon educational and scientific observation and experimentation so to give it a factual basis worthy of the spirit of science, which is the foundation of the association. The committee is, however, charged with the responsibility of investigating and reporting upon the question.

The Commonwealth Fund has provided financial support for initiating this work. Those interested in science education will heartily welcome the interest shown by the officers of the A. A. A. S. and the support provided by the Commonwealth Fund.

Previous Reports Regarding Secondary School Science

In the report of the Committee of Ten in 1893, there appeared very definite statements of objectives and lists of recommended science subjects. This highly valuable report served a useful purpose for the sciences as for other school subjects in the years immediately following its appearance. Science advanced so rapidly, however, that the 1893 report soon became less than an adequate record of accomplishment in science teaching.

In 1913 a National Education Association committee of fifty science teachers began work upon the reorganiza-

tion of secondary science teaching. This committee worked under the guidance of the United States Bureau of Education. Its report appeared in 1920 and was widely distributed. The purposes, outlines of subjects and sequences of subjects as presented in the 1920 report were based upon practices then in use in the more advanced school systems. Since the report was issued the types of courses and sequences advocated have become fairly common. Limitation in time of pupils in which they may take courses in science, and limitation in availability of teachers with desired preparation have prevented many pupils from securing as much instruction in science as thought desirable. Furthermore, the failure of the content, method and organization of science courses to recognize the most insistent needs of modern social, industrial and esthetic living is thought to have kept some of the objectives of the 1920 report from being as widely realized as was expected.

Summaries Regarding the High School Science Situation

The following summaries are presented to show the present situation in representative schools as to sequences of science subjects and relative student registration in each subject.

Sample Summaries of Specific Studies

1. A Summary of the Pennsylvania State Report for 1923 on Status of Sciences in All Four Year High Schools

(a) Of 1,005 high schools general science in 910 schools—Required in 76.9 per cent. and elective in 23.1 per cent. in first year high school; 2.6 per cent. elective in second year high school;
that is, of the 53,904 pupils in general science
53,273 " are in first year.
Of all high school pupils in Pennsylvania in 1923, 26.3 per cent. were studying general science.

(b) Biology in 871 schools—Required in 51.5 per cent. and elective in 48.5 per cent.
29,638 pupils in biology—14.6 per cent. of all high school pupils;
26,881 of these were in second year (10th grade) of the high school;
2,148 in first year of the high school;

(c) Physics in 728 schools—Required in 36.4 per cent. and elective in 63.6 per cent.
19,704 pupils in physics 9.7 per cent. of all high school pupils;
14,216 " " third year (11th grade);
4,800 " " fourth year;
664 " " second grade;
24 " " first year;

(d) Chemistry in 528 schools—Required in 18.2 per cent. and elective in 81.8 per cent.
17,715 pupils—8.7 per cent. of all high school pupils;
10,975 " in fourth year;
6,733 " " third year;
7 " " second year;

(e) Agriculture in 328 schools:
4,003 pupils 1.5 per cent. of all high school pupils.

(f) Physical geography in 88 schools:
3,447 pupils 1.2 per cent. of all high school pupils.

(g) Astronomy in 3 schools:
119 pupils.

(h) Geology, 58 pupils.

(i) In Pennsylvania there was an increase of 19.8 per cent. in the total high school enrollment in the sciences in 1922–23 as compared with 1921–22.

2. Bolton, F. E., "Should physics be required for the university?" *Sch. Rev., 32;* p. 433 (1924).

Table II Distribution of 47,804 high school pupils in Washington in the different science subjects in which they were enrolled.

Physics	4,200	
Chemistry	3,288	
Botany	2,673	
Zoology	1,061	6,332
Biology	1,604	
Physiology	994	
General science	7,802	
Physical geography	1,322	
Geology	54	
Astronomy	2	

3. Science sequences.

The Distribution of the Various Sciences Indicated on the 286 Reports Received 1920–21

Subjects	GRADES									
	7th & 8th		9th		10th		11th		12th	
	No.	%	No.	%	No.	%	No.	%	No.	%
General science	77	26.8	198	68.9	17	5.9	3	1.0	2	0.6
Biology	7	2.4	23	8.0	109	37.9	21	7.3	16	5.4
Botany	2	0.6	36	12.5	98	34.1	36	12.5	24	8.3
Zoology	1	0.3	12	4.1	59	20.6	20	6.9	7	2.4
Physiology	51	17.7	35	12.2	42	14.6	47	16.5	29	10.1
Chemistry	0	0	5	1.7	14	4.8	154	53.6	186	64.8
Physics	1	0.3	7	2.4	38	13.2	180	62.7	148	51.5
Physiography	3	1.0	40	13.9	38	13.2	22	7.6	15	5.2
Geography	7	2.4	24	8.3	31	10.8	18	6.2	14	4.8
Domestic science	6	2.0	11	3.8	9	3.1	5	1.7	5	1.7
Agriculture	11	3.8	4	1.3	10	3.4	7	2.4	5	1.7
Astronomy	0	0	1	0.3	0	0	3	1.0	8	2.7
Psychology	0	0	0	0	0	0	2	0.6	1	0.3

Mr. James A. Keech, teacher of sciences in North Carolina, made a study of the science subjects and their tendency toward a definite sequence arrangement in 286 high schools selected at random through the country. His tabular report is given below:

4. Dr. George W. Hunter, Knox College, Galesburg, Ill., is just completing a study of 274 schools most of which were included in a previous study made by him over 15 years ago. He finds that of the 274 schools reporting, 184 now teach general science in the first year of the four-year high school and that 56 others teach general science in regularly organized junior high school divisions. In the second-year high schools 242 of the 274 teach biology or one of the separate biological sciences. In the third year 150 teach chemistry and 167 physics, and in the fourth year 158 teach chemistry and 135 physics. This study, still unpublished because new data are to be added, shows the same general tendency to adopt a definite high-school science sequence of the type elsewhere set forth.

Help Desired by Those Who Organize Science Sequences

There is a widespread interest in securing a closer relation between science subjects in the different years of schools and junior colleges. A careful study of the results of the many experiments on these questions, a consideration of the inherent relations of science subjects, a study of the amount of time and the conditions involved in science courses, should result in a formulation which might be very generally useful. Such a formulation might prove a guide without fostering the development of a stringent standardization.

Help for Those Who Build Science Laboratories

All know that the science situation in schools and colleges is different from two decades ago. These differences appear in magnitude of the problem, nature of classes, relation of lecture, discussion, laboratory and field work, and in other important points. This would seem to require a study of the appropriateness of the construction designed for use in science work. New types of construction are being devised and their usefulness should be considered and any possible improvements should be made available to all who plan new buildings. The physical provisions should be made to accord with the types of instruction thought to be best.

Further Investigations of Science Teaching Problems

There are many needs for intensive studies on topics related to science teaching. It will prove helpful if the committee may assemble these with brief synopses of their purposes and methods of work, and results when the work has proceeded far enough to be so reported. Also, requests are frequently made for assistance in guiding studies. The committee may not be able to assist in such studies, but the whole question may properly be one for the committee's consideration.

A Synthetic View of Science

There was an early period of the naturalists or natural history men. These had a comprehensive view of science, but few of them were intensive students in any one field of science. They were descriptive scientists in the main.

Then came the period of intensive specialists, which probably must continue even to greater specialization than we now have. But in gaining high specialization we lost general views. We now need a synthesis of sciences, general views, common interpretation of the meaning of science. We need to develop this synthetic interpretation without losing or reducing specialization. Indeed synthesis is essential as a background or a foundation for understanding the necessity and value of high specialization.

May not science secure for many people, both those who are intense students of science and those who study it briefly and broadly, an "appreciation of the universe" which is something beyond mere science knowledge, but no less real. Most teachers teach knowledge, few teach appreciation. May we not come to sense an interlocking of various fields of knowledge, a trained feeling for the value and significance of "things in general" based upon but rising much above the results of our own specific scientific studies. One outstanding scientific critic says: "What always is most astounding to me is that people may know many things of science and still have feeling responses as though the universe were quite different from what they know it to be." Are "college departments busy teaching teachers to teach teachers to teach?" Or are they busy teaching people to be, to see and to respond as truly parts of an appreciative and responsible group who desire scientific truth for the sake of its whole service; not just to record it bit by bit in its proper and logical arrangement with other truths of its own kind. In our necessary separate specialization, have we not reached a point when we must climb upon some sort of vantage position and get the whole landscape again and often? Else the truly engaging general views shall not only be lost but we lose the ability to sense them if they should come.

College Courses in Science

Most college courses in science appear to have been designed as parts of series of courses arranged for those students who are to study a particular science. Students frequently express a desire to study several sciences as part of a whole college program of studies. It is said that college science departments are inclined to regard students as departmental perquisites, once the students have begun to take courses in a given department, and that the departments recommend and urge intensive and technical work in one branch of science, to the inhibition of a general foundation in sciences. Because of these things it is claimed that college students in many institutions regard the science courses as set up for those who already have a start in science subjects.

Teacher Training School Courses in Science

The normal school and teachers college situation is important. In spite of the limitation in these institutions the brief general courses given often provide a general foundation which is very different but probably no worse than the highly differentiated and unbalanced college work in the sciences. Since many secondary school

teachers and other citizens are being educated in these normal schools and teachers colleges in rapidly increasing numbers, it is important that some adequate plan of science instruction be incorporated in those institutions. What can be done or should be done?

SUPPLY OF SCIENCE TEACHERS

A larger and better trained supply of science teachers in secondary schools and colleges is needed. Due to the most commendable increases in salaries and the accompanying better social status of science teachers, more men and women are already preparing themselves for science teaching. It is thought that a still higher grade of teachers will be available when there is better understanding of what science as a whole means in current life, and what the different sciences are trying to accomplish.

PUBLICATIONS POPULARIZING SCIENCE

In an age and in a country in which all the people are to have education in so far as they have capacity for it, at a time when science knowledge has made such advances, and when every activity of common life is conditioned by its relations to modern science knowledge, it is important that consistent, prolonged and definitely planned programs be put into operation for adequate popularization of modern science knowledge. The reception by the public of efforts in this direction indicates an encouraging readiness to receive and use such popular and authoritative publications.

SCIENTIFIC METHOD IN COMMON AFFAIRS

It seems desirable that there should be presented a series of specific illustrations of how the scientist's method of working may be useful in the common affairs of people in non-scientific pursuits. Being guided by the facts, is now becoming a useful slogan in certain commercial and industrial institutions. The inefficiency which accompanies failure to make a scientific analysis is in contrast with the less wasteful results secured when dependable analyses are made.

REGARDING OBJECTIVES IN SCIENCE TEACHING

There are many statements of the ends to be sought in science courses. These statements are probably incomplete and certainly are not harmonious. There is needed adequate technique for assembling, classifying and interpreting objectives. If they may not be made harmonious, all points of view may be fairly presented, so that in one report science men may find a well-balanced presentation of the various purposes now held in mind by those who have clearly defined objectives for their work.

WHAT IS MODERN SCIENCE TRYING TO DO?

What is it which modern science is trying to accomplish? Science is trying to encourage the spirit of inquiry, the desire to know, the ability to ask and answer questions for the sake of answers only as they increase interest and ability in answering other questions. Science recognizes that continued evolution of human mind depends upon the continued use of mind in inquiry, in conclusions, in application, in the establishment of new truth. Science accepts Poincaré's statement that "man is the measure of his own universe."

Science asserts that negative ethics is inconsequential as compared with positive. That a socially working belief that principles are operating to produce results in materials is safer and more hopeful than the older notion that it is merely wrong to act in certain ways. Should not the ethical implications of the scientist's notions of the constant evolution of truth, of the constant relations of cause and effect, the necessity of constant fidelity to true principles, be given a clearer setting so that they may be more readily seen both by persons trained in sciences and those not so trained?

As stated elsewhere, the above paragraphs are designed to suggest topics for consideration by the committee and by any others who are interested in making contributions to the committee's work. These topics are presented for the purpose of giving the committee a start in its work, not to limit or control the committee's work. Please send suggestions to the chairman.

OTIS W. CALDWELL, *Chairman*
425 WEST 123RD STREET,
NEW YORK, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE FIFTH WASHINGTON MEETING

PREPARATIONS for the approaching Washington meeting of the American Association and associated organizations are approaching completion. The preliminary announcement of the meeting, a booklet of 90 pages, was in the mails before December 1 and should have reached all members long before these notes are published. Lists of the local committees for the Washington meeting have been given in SCIENCE for August 29, 1924, and lists of the forty-four societies that are to meet with the association this year have appeared in these pages for August 29 and November 28. The secretaries of the sections and societies have been generally very helpful in sending in material and the announcement presents a better picture of the approaching meeting than has been the case in recent years. Extra copies of the preliminary announcement may be had from the permanent secretary's office by non-members as well as members.

The state of the association is very satisfactory; membership has been greatly increased during the last year. At the time of writing these notes (December 2, 1924) the total number of names on the roll is 13,361. And 8,397 have already paid their dues for 1925. Besides increased membership the asosciation needs increased endowment and increased active, critical and constructive interest on the part of the members and of the affiliated organizations. Especially are members asked to help to increase the number of

life members, sustaining members and donors. The next volume of the Summarized Proceedings, which is to be published next year, is being prepared for. It will contain the directory of members. It may be ordered at a price of $1.50 to members if paid for in advance before next January 1.

One of the outstanding features of the fifth Washington meeting will be the awarding of the second American Association prize of $1,000, which is to be awarded to the author of some noteworthy contribution to scientific advancement presented in the programs of the meeting. Membership in the association will not be considered in making the award.

Besides the opening session on Monday evening, December 29, at which Dr. Charles D. Walcott, secretary of the Smithsonian Institution, will give the retiring presidential address, there will be a number of other general sessions of the association. On Tuesday afternoon, Mr. Austin H. Clark, of the Smithsonian Institution and a member of the Navy Department's Advisory Committee on Oceanography, will give an illustrated talk on the navy's oceanographic program. On Tuesday evening Dr. Frederick Fuller Russell, general director of the International Health Board, will give the third annual Sigma Xi lecture, under the joint auspices of the American Association and Sigma Xi. His subject will be, "War on diseases, with special reference to malaria and yellow fever." Dr. Charles D. Walcott will give an illustrated public lecture on Wednesday afternoon on "Geological explorations in the Canadian Rockies." On Thursday afternoon Professor A. E. Douglass, director of the observatory of the University of Arizona, will give an illustrated public account of the University of Arizona eclipse expedition of September, 1923. A series of motion pictures taken on the western trip following the recent Toronto meeting of the British Association for the Advancement of Science will be shown on Thursday evening by Dr. Edwin E. Slosson, director of *Science Service*. Dr. Willis T. Lee, of the U. S. Geological Survey, will give an illustrated account, on Friday afternoon, of his recent explorations of the Carlsbad Caves of New Mexico.

The plans for a much improved exhibition of research apparatus, methods, books and products have been previously noted in these pages (August 29, 1924). The general exhibition will be located in the gymnasium of George Washington University and there will be numerous special exhibitions in connection with the sessions of the various societies. The Carnegie Institution of Washington invites those in attendance at the meeting to visit its Administration Building, where an exhibition of the work of the institution may be viewed. Many of the government laboratories will be open for inspection. The National Geographic Society is cordially planning entertainment for the geographers. Dr. Chas. A. Shull, of the University of Chicago, is acting as manager of the association exhibition this year, and Mr. W. J. Showalter, of the *National Geographic Magazine*, is chairman of the local subcommittee on exhibition. It is not too late for scientific workers to secure space for exhibiting new research methods and apparatus. It is hoped that exhibits by individual men of science may form an important part of the exhibition this year.

As has been announced, reduced railway rates are to be available to practically every one who will attend the fifth Washington meeting. Virtually the whole of the United States and all eastern Canada are in the region of stations from which the reduced rates apply. Purchasers of tickets to Washington should read carefully the instructions given in the preliminary announcement of the meeting. They are to state that they are going to attend the meeting of the American Association for the Advancement of Science, buying a one-way ticket to Washington and securing a certificate for the American Association meeting. This ticket will be validated after presentation at the registration room in the New Willard Hotel, and it will then entitle the holder to purchase a return ticket at one half the regular fare. It will make no difference whether holders of certificates are members of the association or of associated societies or of other societies meeting with the association this year. To help defray the extra expenses of the Washington meeting a fee of fifty cents will be collected for each railway certificate endorsed and validated. This fee is not for the railway companies but is to help finance the meeting.

The members of the association residing in and near the District of Columbia have been asked for contributions to help defray the large extra expense of this meeting, and very many of them have responded in a cordial and generous manner. Those who come to the meeting will greatly appreciate the generosity and hospitality of the local members.

A list of Washington hotels, with prices, etc., has been prepared by Dr. Albert L. Barrows, chairman of the subcommittee on hotels, and this is published in full in the preliminary announcement. The New Willard Hotel is to be general headquarters for the American Association itself, and many of the other organizations that are to take part in the Washington meeting have arranged for other hotels as their headquarters. Reservations should be made as early as possible. The Washington Young Men's Christian Association and Young Women's Christian Association keep lists of available rooms, which may be secured at rates considerably lower than those of hotels. It is suggested that many of those who attend the meeting may practice a laudable economy by securing

rooms for the week through the above-mentioned sources.

One of the most difficult tasks that confront our local committees when they take up the work of making preliminary arrangements for the annual meetings is that of assigning session rooms to the numerous sections and other organizations that meet with the association. That task has been exceptionally difficult this year because there is in Washington no single group of buildings suitable for housing such a meeting as ours. Dean Hugh Miller, of the Engineering School of George Washington University, has charge of the assignment of meeting places and he has been ably assisted by Mr. Henry F. Haase and the local representatives of the sections. Dean Miller has succeeded in arranging for all the sessions that will occur, but a certain amount of scattering is made necessary by the nature and location of the buildings that are available. The biological groups will meet in the Central High School building, other groups will meet in the rooms of George Washington University, still others in rooms of the U. S. Bureau of Standards, the U. S. Geological Survey, the National Geographic Society, etc.

A publicity office for the approaching meeting is already in operation, in charge of Mr. Austin H. Clark, of the Smithsonian Institution, chairman of the subcommittee on publicity. Our publicity office is again having the great advantage of cooperation from Science Service, whose director is Dr. Edwin E. Slosson. The office will care for the releasing of news items for the use of the newspapers. All who plan to give papers or addresses at the meeting should be sure that Mr. Clark and Dr. Slosson are both supplied *as soon as possible* with manuscripts and abstracts, which will be used in preparing the publicity material. Nothing will be released to the press until the proper time. This feature of the meeting has been dealt with in some detail in SCIENCE for August 29.

The president of the American Association for the Advancement of Science this year is Dr. J. McKeen Cattell, editor of SCIENCE, who is well known to all American scientific workers. The retiring president is Dr. Charles D. Walcott, secretary of the Smithsonian Institution. The vice-presidents and retiring vice-presidents for the sections are as follows, the present vice-president being named first in each case:

Section A (Mathematics): J. C. Fields, University of Toronto; Harris Hancock, University of Cincinnati.

Section B (Physics): K. T. Compton, Princeton University; W. F. G. Swann, University of Chicago.

Section C (Chemistry): F. G. Cottrell, Fixed Nitrogen Research Laboratory, U. S. Department of Agriculture; E. W. Washburn, National Research Council.

Section D (Astronomy): John A. Miller, Swarthmore College; Heber D. Curtis, Alleghany Observatory.

Section E (Geology and Geography): W. C. Mendenhall, U. S. Geological Survey; N. M. Fenneman, University of Cincinnati.

Section F (Zoological Sciences): Edwin Linton, 1104 Milledge Road, Augusta, Ga.; E. L. Rice, Ohio Wesleyan University.

Section G (Botanical Sciences): G. R. Lyman, West Virginia University; C. J. Chamberlain, University of Chicago.

Section H (Anthropology): E. A. Hooton, Peabody Museum; E. A. Hooton, Peabody Museum.

Section I (Psychology): R. S. Woodworth, Columbia University; G. Stanley Hall, deceased.

Section K (Social and Economic Sciences): Thomas S. Baker, Carnegie Institute of Technology; John F. Crowell, 171 Liberty St., Bloomfield, N. J.

Section L (Historical and Philological Sciences): Louis C. Karpinski, University of Michigan; Florian Cajori, University of California.

Section M (Engineering): A. E. Kennelly, Harvard University; John T. Faig, Ohio Mechanics Institute.

Section N (Medical Sciences): William A. MacCallum, Johns Hopkins University; Richard P. Strong, Harvard University Medical School.

Section O (Agriculture): L. R. Jones, University of Wisconsin; R. A. Pearson, Iowa State College.

Section Q (Education): L. A. Pechstein, University of Cincinnati; Henry W. Holmes, Harvard University.

The other officers of the association, the roll of council members and the members of the section committees and other committees are given in the preliminary announcement. There are now 139 members in the council. The council will hold its first session for the Washington meeting at the New Willard Hotel on the afternoon of Monday, December 29, at 2 o'clock.

Space does not allow a detailed account here of the numerous sessions that are being planned by the various sections and societies that will take part in this great gathering of scientists. I must simply refer to the preliminary announcement for this all-important aspect of the meeting. It is of special interest that two newly formed scientific societies will hold their initial meetings with the association this year; these are the History of Science Society (F. E. Brasch, *secretary,* Department of Terrestrial Magnetism, Carnegie Institution of Washington) and the American Society of Plant Physiologists (R. B. Harvey, *secretary,* University Farm, St. Paul, Minn.). The Federation of American Societies for Experimental Biology is to meet with the association this year, which

will greatly strengthen the medical and biological features of the meeting. The special committee on Philological Sciences in the Association (Mark H. Liddell, *secretary*, Purdue University, LaFayette, Ind.) has prepared an excellent program dealing with problems and projects in linguistic research. It is hoped that linguistic scientists as well as those interested in the historical sciences may soon have the advantage of organization in the American Association. The section on Social and Economic Sciences will present a full and important series of invited papers on the general topic, "New problems of Western civilization." The American Political Science Association will this year meet in Washington along with the American Association for the Advancement of Science. The British Ambassador to the United States, Sir Esme Howard, will address the political scientists on "British policy and the balance of power." The Engineering Section will hold sessions on engineering research and the relation of engineering to the fundamental sciences. The recent rapid influx of new association members from among the engineers gives promise of increased activity on the part of this section. The Society of American Foresters will give prominence at the Washington meeting to the newer phases of forestry in the United States and the plans and projects that confront this nation in regard to forests and forest products.

BURTON E. LIVINGSTON,
Permanent Secretary

SCIENTIFIC EVENTS

NATIONAL PARK MUSEUMS

THE national park museum project, begun several years ago with the establishment of a small field collection in Yosemite, has progressed slowly, lacking adequate funds, and has been sidetracked through the absorption of the National Park Service in more pressing problems. The formation of a committee on Museums in National Parks on the suggestion of Stephen T. Mather, director of the service, and the laying of the cornerstone for a new museum in Yosemite National Park on November 16, are important steps in the program.

The museum building was made possible through an appropriation of $70,500 from the Laura Spelman Rockefeller memorial fund. Valuable exhibits already have been collected under the direction of the committee on museums, and plans now being formulated call for a historical and scientific library, and halls to exhibit progressively the geologic development of the Yosemite Valley and the so-called "Life Zones" from the California plains to the summit of the Sierras. It also will serve as headquarters for the Nature Guide System.

This new and modernly equipped institution, which is expected to become one of the nation's greatest treasures of scientific and natural history exhibits, takes the place of a small museum collection begun in 1919 by Ansel F. Hall, park naturalist for Yosemite. He also worked with Mr. Mather in perfecting the Nature Guide System, by which visitors to the national parks see their wonders under expert guidance. The original exhibition was collected and arranged entirely by Mr. Hall, who even made his own exhibition cases by hand, there being no appropriation to purchase needed equipment. The little museum became so popular that it was realized there was a public demand for more adequate showing of the natural park specimens—geologic rock formations, wild flowers and foliage, and specimens of woods found only in certain regions.

The personnel of the Committee on Museums in National Parks which will have charge of this phase of national park development is as follows:

Chauncey J. Hamlin, chairman; Dr. Clark Wissler, curator of anthropology, American Museum of Natural History, vice-chairman; Robert Sterling Yard, executive secretary National Parks Association, secretary; John B. Burnham, president of the American Game Protective Association; Dr. H. C. Bumpus, of Brown University; Laurence Vail Coleman, secretary of the American Association of Museums; Dr. A. R. Crook, chief of the Illinois State Museum; Dr. Vernon Kellogg, secretary of the National Research Council; Dr. Frederic A. Lucas, honorary director, American Museum of Natural History; Dr. John C. Merriam, president of the Carnegie Institution of Washington; George D. Pratt, vice-president of the Brooklyn Museum of Arts and Sciences, and Professor Charles L. Richards, director of the American Association of Museums.

TANNING RESEARCH LABORATORY AT THE UNIVERSITY OF CINCINNATI

AMONG the activities which marked the annual meeting of the Tanners Council of America at Cincinnati, from November 18 to 20, was the dedication of the council's new research laboratory. Here the studies of the fundamentals of leather manufacture that have been made by Professor G. D. McLaughlin will be continued and extended. Professor McLaughlin, as director of the laboratory, assisted by E. R. Theis, in charge of chemical work; Dr. G. E. Rockwell, in charge of bacteriological work, and Daisy M. Baehr, histologist.

The laboratory is on the grounds of the University of Cincinnati and the funds for its establishment, approximately $110,000, were raised by the Tanners Council. On Wednesday, November 19, the members

of Tanners Council and the American Leather Chemists Association were welcomed by Dr. Frederick C. Hicks, president of the University of Cincinnati. In the absence of Secretary Hoover, Dr. Martin H. Fischer spoke on the significance of this undertaking. He was followed by Dr. J. S. Rogers, president of the American Leather Chemists Association. President Fraser M. Moffat, of Tanners Council, then presented the laboratory to the University of Cincinnati and it was accepted on behalf of the directors by President Hicks.

In the three-story brick building there are laboratories well equipped for fundamental research on all phases of leather. The large staff laboratories are supplemented by smaller ones for students who have qualified themselves to do special work. The whole undertaking is an example of cooperative fundamental research fostered by an industrial association.

LABORATORY FOR THE STUDY OF THE PHILOLOGICAL SCIENCES AT THE UNIVERSITY OF MICHIGAN

Dr. A. R. Morris, of the department of rhetoric in the University of Michigan, has sent the following communication to Professor Alfred H. Lloyd, dean of the graduate school of the university:

I am directed to report to you the action of a conference of representatives of seven departments held yesterday to consider plans for mobilizing resources in the interest of laboratory study of phonetics, philology and language form. The movement grows out of a proposal made last December before the Philological Section of the American Association for the Advancement of Science by Professor Cottrell. The suggestion seemed so timely that it ought not go unrealibed.

To meet the needs of philologists not provided with laboratories, it was suggested that a laboratory be established, somewhere in the country, equipped to make records for all comers. Such a laboratory adequately fitted and manned involves greater expense than any institution is just now in a position to meet. Until a way is found through the National Research Council or otherwise to provide such facilities, or until some other feasible plan is worked out, it seemed that something might be done immediately in this direction by pooling the laboratory resources of equipment and personnel. After some preliminary conferences seven departments have taken steps to pool their resources and to offer their combined equipment to any one wishing to make speech records for analysis. By this combination we should be able soon to provide facilities for recording by any of the methods so far developed and to provide material assistance in the analysis of curves for the study of tone quality.

The seven departments cooperating are psychology, physics, rhetoric, physiology, phonetics, mathematics and public speaking. Our proposal is, perhaps, only a stopgap to serve until something better is developed, but so far as this plan can be made to advance the laboratory study of linguistic problems these seven departments are glad to offer their services.

CHEMISTRY AT THE WASHINGTON MEETING OF THE AMERICAN ASSOCIATION

An interesting program will be presented to the chemists at the Washington meeting of the American Association for the Advancement of Science, beginning on Tuesday, December 30, at 10 A. M. The meeting is under the auspices of the Washington and other eastern sections of the American Chemical Society and Section C of the association, but all chemists and others interested are invited to attend.

The address of the retiring vice-president of the association, Dr. E. W. Washburn, editor of the International Critical Tables, will be presented on Wednesday afternoon on the subject "Some effects of the weather upon physical measurements."

A symposium on X-rays in chemistry has been arranged, and will probably be held on Thursday afternoon. Dr. Arthur H. Compton will present an illustrated paper on X-rays and their scattering by electrons; Dr. Ralph W. Wyckoff, of the Geophysical Laboratory, will consider the topic "X-rays and crystal structure"; Dr. W. P. Davey, of the General Electric Company, will talk on "Atomic and ionic radii," and Dr. George L. Clark, of the Massachusetts Institute of Technology, will give a paper on "The versatility of x-rays."

A few of the other papers to be presented are listed below:

Illustrated lecture on gels and colloids, H. N. Holmes, Oberlin College.

European laboratories, W. A. Noyes, University of Illinois.

Excited atoms, K. T. Compton, Princeton University.

New aspects of some fundamental properties of matter, Eugene C. Bingham, Lafayette College.

A method of establishing a potential gradient for organic radicals, M. S. Kharasch, University of Maryland.

The electronic conception of adsorption from the standpoint of gels, Neil E. Gordon, University of Maryland.

Some causes of volcanic activity, A. L. Day, Geophysical Laboratory.

The interpretation of band spectra, Robert S. Mulliken, Harvard University.

The relation between the static and the dynamic concepts of the atom, Harold C. Urey, Johns Hopkins University.

Influence of sulphur on the color of dyes, E. Emmet Reid, Johns Hopkins University.

Electric moments of molecules, Charles P. Smythe, Princeton University.

Catalysis in homogeneous systems, F. O. Rice, Johns Hopkins University.

Methods for the determination of densities, M. Haring, University of Maryland.

The present status of thermochemical data, F. Russell Bischowsky, Johns Hopkins University.

The status of the electron in the teaching of chemistry, Neil E. Gordon, University of Maryland.

Errors in experimental work as illustrated by determinations of surface tension, T. F. Young and W. D. Harkins, University of Chicago.

The complete program will be published later.

On Tuesday afternoon the chemists will meet with the physicists and the astronomers.

Hotel Raleigh has been chosen as headquarters for the chemists.

WILLIAM D. HARKINS,
Secretary of Section C

SCIENTIFIC NOTES AND NEWS

DR. K. T. COMPTON, professor of physics in Princeton University, has been elected chairman of Section B (Physics) of the American Association for the Advancement of Science and association vice-president for that section, to fill the place left vacant by the death of Dr. Ernest Fox Nichols.

DR. WILLIAM F. DURAND, professor emeritus of mechanical engineering in Leland Stanford University, was installed as president of the American Society of Mechanical Engineers on December 2. Vice-presidents chosen for the coming year are Sherwood F. Jeter, of Hartford, Conn.; Professor Robert W. Angus, of Toronto, and Thomas L. Wilkinson, of Davenport, Ia.

DR. HUGH K. MOORE, director of research, the Brown Company, Berlin, N. H., has been awarded the Perkin Medal for 1924 in recognition of his chemical engineering attainments in the fields of salt, sulphur and cellulose. It will be presented at the meeting of the New York section of the Society of Chemical Industry on February 6.

DR. CHARLES S. SARGENT, director of the Arnold Arboretum, has been awarded the Lodor Rhododendron Cup of the Royal Horticultural Society of England.

THE first presentation of the new Holley Medal of The American Society of Mechanical Engineers has been made to Hjalmar Gorrfried Carlson, of Worcester, Mass., "for his invention and processes which made possible the timely production of drawn steel booster castings for artillery ammunition, thereby aiding victory in the World War."

IN connection with the annual meeting of the Indiana Academy of Sciences, held at Purdue University on December 5, a dinner was given in honor of Dr. J. C. Arthur and Dean Stanley Coulter. Addresses were given by Dr. John Merle Coulter, of the University of Chicago, and Dr. William Trelease, of the University of Illinois.

RAMON Y. CAJAL, professor of histology at the University of Madrid, has had conferred upon him an honorary degree by the University of Paris.

PROFESSOR C. F. CURTIS RILEY, connected with the department of zoology at the University of Manitoba, formerly of Syracuse University, New York, has been elected a fellow of the Entomological Society of London.

THE Langley Memorial Prize of the London School of Hygiene and Tropical Medicine has been awarded to Dr. P. S. Selwyn-Clarke, of the West African Medical Service, for his monograph on small-pox in the negro and negroid tribes of British West Africa.

PROFESSOR FRANCIS VEJDOVSKY, senior of Czech zoologists, and formerly professor at Czech University in Prague, celebrated his seventy-fifth birthday on October 24.

EDOUARD BRADLEY, pioneer French worker in wireless telegraphy, celebrated his eightieth birthday on November 8.

PROFESSOR ETHAN ALLEN SHAW, for twenty-five years professor of mathematics at Norwich University, will retire at the close of the present semester.

M. ALBIN HALLER, professor of organic chemistry, and M. Joannis, professor of chemistry at the University of Paris, have retired.

PROFESSOR A. BIEHL has retired from the Astrophysical Observatory at Potsdam, having reached the age limit, and Dr. Baron von der Pahlen has been appointed to take his place.

IT is announced that Dr. Aldo Castellani, director of the department of tropical medicine at the Ross Institute, London, has been offered the directorship of the new School of Tropical Medicine at Tulane University, New Orleans.

PROFESSOR M. DOELLO-JURADO, of the University of Buenos Aires, has been appointed director of the National Museum of Natural History at Buenos Aires.

MARTIN FROBISHER, JR., for the past three years with the Maryland State Health Department, has been appointed chief, division of chemistry, Baltimore City Health Department.

C. E. BALES, who is president of the Louisville Section of the American Chemical Society, has been made assistant manager, in charge of production, at the Louisville Fire Brick Works.

UPON invitation from Dr. A. A. Noyes, Dr. J. J. Abel, professor of pharmacology at the Johns Hopkins University, has gone to the California Institute of Technology at Pasadena to try to isolate the active principle in insulin by methods used on pituitary extract. Dr. E. M. K. Geiling, of the university, ac-

companied Dr. Abel. They will return about March 1, 1925.

Dr. A. L. Bloomfield, associate professor of medicine, and Dr. A. Keidel, associate professor of clinical medicine, have been given leave of absence by the Johns Hopkins University for one year to study abroad in European clinics.

Dr. Eliot Jones is taking a year's leave of absence from Stanford University and is serving as professor of railway transportation on the McKinley Foundation at the University of Illinois.

Dr. P. H. Rolfs and family returned to the United States on December 8 for a short vacation. Dr. Rolfs has been employed by the State of Minas Geraes (Brazil) for the last four years, in the construction and organization of an Agricultural College on the North American plan. He will remain in the United States until about March 15, and will then return to Minas Geraes for another period of four years. His headquarters while in the United States will be in Gainesville, Florida. The site of the Agricultural College is at Viçosa, on a plateau over six hundred meters high, in the Sao Geraldo Mountains. The main building is approaching completion and the experimental grounds are well developed.

Dr. S. Z. de Ferranti has returned to England after a tour of the United States and Canada. At the conclusion of the tour on November 6, a luncheon was held at the Yale Club, New York, in honor of Dr. Ferranti. The luncheon was given under the auspices of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Mining and Metallurgical Engineers and the American Institute of Electrical Engineers.

A group of five physicians from Central Europe holding fellowships under the division of medical education of the Rockefeller Foundation arrived in the United States November 20 for graduate study in preparation for medical teaching in their own countries. Three of the physicians, Dr. Slavko Pejich, Dr. Urosh Ruzitchitch and Dr. Radoji Taditch, are from Yugoslavia; one, Dr. Andrew Bosanyi, is from Hungary, and one, Dr. Leopold Schonbauer, is from Austria.

Miss Mary Beard, formerly director of the Instructive District Nursing Association of Boston, sailed on November 29 for England, where she will conduct, under the auspices of the division of studies of the Rockefeller Foundation, a survey of maternity care with special reference to the relation of midwifery to nursing.

Dr. C. A. Browne, chief of the bureau of chemistry of the United States Department of Agriculture, will speak on the subject of "Past and future of agricultural chemical research" before the regular meeting of the New York section of the American Chemical Society at Rumford Hall on December 12.

Dr. A. E. Douglass, professor of astronomy at the University of Arizona, gave an illustrated lecture entitled "Cycles in development of tree rings as an evidence of climatic variation," at the Carnegie Institution of Washington, on December 5.

Dr. Francis G. Benedict, director of the Nutrition Laboratory of the Carnegie Institution of Washington, in Boston, recently gave a lecture on "The measurement and significance of basal metabolism" at a number of universities and medical schools in the middle west. This lecture tour was under the auspices of the Mayo Foundation. During the week of November 17–22 Dr. Benedict addressed audiences at the University of Wisconsin, the Mayo Clinic, the University of Minnesota, the Medical School of the University of Nebraska, the Washington University Medical School and the University of Iowa.

At the University of Arizona during the week of November 17 to 21, Dr. F. W. Upson, of the University of Nebraska, gave a series of five experimental lectures on the chemistry of colloids. He also spoke at the university assembly on the relation of chemistry to medicine.

Dr. John W. Gowen, of the Maine Agricultural Experiment Station, Orono, addressed the scientific staff of the Rockefeller Institute for Medical Research on December 5 on "The secretory activity of the mammary gland and some of its problems."

On November 22 Dr. Arthur Willey, F.R.S., of the department of zoology of McGill University, Montreal, delivered an address to the Royal Canadian Institute, Toronto, on the subject "A trip to the great lake Mistassini."

Dr. Theodore Hough, dean of the medical department and for seventeen years professor of physiology at the University of Virginia, has died at the age of fifty-nine years.

Dr. Alfred Hulse Brooks, for twenty years chief of the Alaskan division of the U. S. Geological Survey, died on November 21, aged fifty-three years.

Professor Spencer Ambrose Beach, vice-dean of agriculture and professor of horticulture at Iowa State College, died on November 2, in his sixty-fifth year.

Dr. John B. Roberts, formerly professor of surgery at the University of Pennsylvania and a former president of the American College of Surgeons, died on November 29, aged seventy-two years, from injuries received when he was struck by an automobile.

Dr. Rudolph Menn, Chicago surgeon, formerly

dean and vice-president of Jenner Medical College, died on December 3.

THE Biological Club of the University of Minnesota held its two hundredth meeting on October 20. Dr. B. H. Blackman, of the Imperial College of Technology, London, was a special guest of honor. Other special guests included President L. D. Coffman, Dean Guy Stanton Ford, of the graduate school; Dean E. P. Lyon, of the medical school; Dean J. B. Johnston, of the college of science, literature and arts, and Dean W. C. Coffey, of the department of agriculture, all of the University of Minnesota.

THE Washington Section of the American Chemical Society held its annual election on November 13, selecting L. H. Adams as president, R. Gilchrist as secretary and H. W. Houghton as treasurer. Newly elected members of the executive committee are: Wm. Blum, V. K. Chesnut, R. B. Sosmann, M. X. Sullivan, E. W. Washburn and E. T. Wherry; Councillors: F. G. Cottrell, W. M. Clark, S. C. Lind and R. S. McBride. Preceding the meeting a dinner was given in honor of Dr. E. F. Armstrong, a prominent British industrial chemist and formerly president of the Society of Chemical Industry. At the opening of the meeting Dr. Armstrong spoke for a few minutes on the present trend in chemistry, stressing particularly the work now in progress in catalysis and surface phenomena and predicting great advances in the near future.

UNIVERSITY AND EDUCATIONAL NOTES

PORTER L. NEWTON, of Waltham, has given the residue of his estate to the Massachusetts Agricultural College to be used through the awarding of scholarships designed to promote and improve the agricultural situation in the state. The gift will probably amount to about $25,000.

THE Carnegie Corporation has given to Dalhousie University the sum of $190,000. Of this amount $90,000 will go toward payment of accumulated deficits, while the remainder will be divided into five annual payments of $20,000 each as a fund to forestall future deficits.

WE learn from the *Journal* of The American Medical Association that many prominent Japanese and Chinese officials attended the recent opening of the medical school of the Chingtao Hospital, which has been erected by the Japanese government, says the *Japan Medical World,* as one of Japan's enterprises for the education of Chinese students. The school will be maintained by the hospital and by a subsidy of 140,000 yen per annum from the Japanese government.

THE cornerstone of the new buildings of the University of Brussels was laid on November 20. The new building has been made possible by financial assistance, amounting to nearly 20,000,000 francs, given by the Commission for Relief in Belgium and the Educational Foundation. The American Relief Commission provided food for the Belgian population during the German occupation, and the 20,000,000 francs have been paid out of the balance remaining over from the fund.

DR. A. H. RYAN, formerly professor of physiology at Tufts College Medical School, Boston, has been appointed professor of physiology at the University of Maryland School of Medicine and the College of Physicians and Surgeons, Baltimore.

DR. W. L. HOLMAN, associate professor of bacteriology at the Johns Hopkins University, has been appointed associate professor at the University of Toronto Medical School.

L. J. PESSIN, PH.D. (Johns Hopkins, 1923), has accepted a position as assistant professor of plant physiology at the North Carolina State Agricultural and Mechanical College.

A. W. BELLAMY recently resigned his position as assistant professor of zoology at the University of Chicago and went to the University of California, southern branch.

AT Tufts Medical College, Dr. Frank Howard Lahey, professor of surgery, and Dr. Charles Davison Knowlton, assistant professor of theory and practice of medicine, have resigned.

ABRAHAM PRESS, at one time demonstrator in physics and mathematics at the Southwestern Polytechnic Institute, London, and recently technical science expert, Interdepartmental Radio Board, Washington, D. C., sailed for Siam on December 3 *via* Europe to accept the post of professor of physics in the premedical school of Chulalongkorn University, Bangkok.

DR. BETHE, professor of physiology at the University of Frankfurt, has been called to take the place of Dr. Rudolph Metzners, retiring professor at the University of Basel.

DISCUSSION AND CORRESPONDENCE

GENERAL PLAN FOR MAGNETIC AND ALLIED OBSERVATIONS DURING THE TOTAL SOLAR ECLIPSE OF JANUARY 24, 1925[1]

SPECIAL magnetic and allied observations will be made at stations in or near the path of totality of the solar eclipse of January 24, 1925, by the Depart-

[1] Communicated at the request of the director of the Department of Terrestrial Magnetism.

ment of Terrestrial Magnetism of the Carnegie Institution of Washington, and by various cooperating magnetic observatories, institutions and individuals. One magnetic observatory, that at Agincourt, near Toronto, Canada, lies within the shadow belt. The Coast and Geodetic Survey magnetic observatory at Cheltenham, Maryland, is also very favorably situated, being within 200 miles of the southern edge of the path. The observatories of Great Britain lie near the path, although the sun will set while still eclipsed at those stations.

The general scheme of work is as follows:

1. *Simultaneous magnetic observations* of any or all the elements, according to the instruments at the observer's disposal, every minute from January 24, 1925, $11^h\ 58^m$ to $18^h\ 02^m$ Greenwich civil mean time.

(To insure the highest degree of accuracy, the observer should begin work early enough to have everything in complete readiness in proper time. *Past experience has shown it to be essential that the same observer make the readings throughout the entire interval.* If possible, similar observations for the same interval of time as on January 24 should be made on January 23 and 25.)

2. At *magnetic observatories* all necessary precautions should be taken to insure that the self-recording instruments will be in good operation not only during the proposed interval, but also for some time before and after, and eye-readings should be taken in addition wherever it is possible and convenient. (*It is recommended that, in general, the magnetograph be run on the usual speed throughout the interval, and that, if a change in recording speed be made, every precaution possible be taken to guard against instrumental changes likely to affect the continuity of the base-line.*)

3. *Atmospheric-electric observations* are desirable to the fullest extent possible with the available equipment and personnel. Observations of potential gradient are most easily provided for and most conveniently taken; in addition to these, observations (preferably for both signs) of either conductivity or ionic content are also very desirable. Full notes regarding cloud and wind conditions and, if possible, observations for both temperature and relative humidity should accompany the atmospheric-electric observations. These observations should cover the same interval as the magnetic observations. The value of the observations on the day of the eclipse will be greatly increased if similar observations can be made during the same time of day on two or three days before and after the eclipse.

4. *Meteorological observations* in accordance with the observer's equipment should be made at convenient periods (as short as possible) through the interval. It is suggested that, at least, temperature be read every fifth minute (directly after the magnetic reading for that minute).

5. *Observers in the belt of totality* are requested to take the magnetic reading every 30 seconds during the interval, 10 minutes before to 10 minutes after the time of totality, and to read temperature also every 30 seconds, between the magnetic readings.

J. P. AULT
H. W. FISK

DEPARTMENT OF TERRESTRIAL MAGNETISM,
CARNEGIE INSTITUTION OF WASHINGTON,
WASHINGTON, D. C.

A METHOD OF MAKING PERMANENT SMEARS OF POLLEN MOTHER CELLS

IN some recent work on *Ginkgo biloba* excellently fixed preparations of pollen mother cells in mitosis were obtained by the rapid and simple method outlined below. The desired stage of the anthers was determined by Belling's aceto-carmine method (Belling, J. (1921) *American Naturalist* 55: 573–4). A very thin film of albumin fixative was spread on a slide; then the anther was crushed and its contents distributed upon the slide with a scalpel as evenly as possible. When this was done, the slide was placed in a Coplin jar containing Flemming's medium fixative for 24 hours, washed 5 hours in running water, bleached in hydrogen peroxide and dehydrated and stained with safranin and light green. This method seems worth testing on other plants, since with it permanent records can be kept of material which has been studied by Belling's method. Such records are exceedingly useful for demonstration purposes, since even if the desired plants are in good condition, which can not always be the case, considerable time is consumed in making new preparations for each visiting scientist who wishes to see the actual material described in some published work.

MARGARET C. MANN

UNIVERSITY OF CALIFORNIA

OSMOSIS DEMONSTRATION FOR CLASSES IN BIOLOGY

IN the article, "Osmosis demonstration for biology classes," by Mr. Benjamin C. Gruenberg (SCIENCE, LX, 1555, October 17, 1924), there is described a very excellent method for preparing celloidin bags for this demonstration. There is just one addition to this method, which our technician has found a big assistance.

This is in the preparation of the bottles before

the "new skin" or celloidin is poured into the bottles. This consists of covering the inside of the bottle with a ten per cent. solution of molasses and water. The molasses solution film is allowed to thoroughly dry on the inside of the bottle, before coating the inside of the bottle with the celloidin film. The celloidin film can very easily be removed by simply immersing the bottle in water as this will dissolve the film molasses coating on the bottle.

The only precaution necessary is to be sure that the ether of the celloidin solution has been thoroughly removed before the water is added. As pointed out, the ether will have sufficiently evaporated when the odor of ether is gone.

Our technician has found this a great time-saver; it also eliminates the danger of breaking the bag in removing it from the bottle.

M. W. WELCH

W. M. WELCH SCIENTIFIC COMPANY,
CHICAGO, ILLINOIS

HEARING IN A NOISE

REFERRING to the letter of Dr. G. W. Boot, in SCIENCE of October 17, it seems that many cases of enhanced acuity of hearing of deaf people in the presence of a noise, including one of the cases cited by him, are really cases of greater ease of conversation with a normal hearing person. These may be explained by the fact that the noise bothers the deaf person less than the normal person, due partly to the difference in the levels of loudness to which they are sensitive and partly to the difference in frequency between the noise and the speech, the deaf person being more deficient for the noise frequencies than for the speech frequencies. As Dr. Boot points out, it is people with fixation of the stapes who report the phenomenon, and these people are deaf at the lower frequencies, which is the region of probably most disturbing noises.

I would like to call attention to the desirability of having the test made which was suggested in the March issue of the *Annals of Otology, Rhinology and Laryngology*. If the hearing itself is improved in the presence of a noise, as Dr. Boot maintains, then two such people with similar deficiencies in hearing should be better able to converse *with each other* in noisy surroundings, while if the change usually noted by them is due to the change in loudness with which normal hearing people talk in a noisy place, as is suggested above, then the two deaf people should not find the noise to be of any benefit. It is hoped that some one with clinical material available may try this experiment.

F. W. KRANZ

RIVERBANK LABORATORIES
GENEVA, ILLINOIS

SPECIAL ARTICLES

INFLUENCE OF ULTRA-VIOLET LIGHT ON YOUNG LAYING HENS

WE have found ultra-violet light to have as much effect on the egg production in young laying hens as it has on the bone development in young growing chicks. It is very common for young laying hens, when kept in the absence of ultra-violet light, and on a feed low in the anti-rachitic vitamin, the condition that tends to produce rickets (leg weakness) in growing chicks, to develop a pathological condition characterized by the following symptoms:

(1) The egg production is low.
(2) The eggs produced have very thin shells.
(3) The whites and yolks have less calcium and phosphorus than normal eggs.
(4) A much smaller percentage of these eggs hatch than normal eggs.
(5) Fully developed eggs are often retained in the oviduct, for three or four days.
(6) The hens often develop lameness or paralysis of the legs or wings.
(7) The bones become low in their mineral content and are easily broken.
(8) The calcium and phosphorus content of the blood is below normal.

That ultra-violet light will prevent the above condition is shown by the following experiment which we conducted last winter.

Two lots, of twelve Leghorn pullets each, were placed in the nutrition laboratory October 1, 1923. They were given the same ration, which consisted of yellow corn 82 per cent., tankage 5 per cent., casein 5 per cent., butter fat 5 per cent., bone ash 3 per cent., all ground together in a mash, and all the sprouted oats and oyster shells they would eat.

A cockerel was placed in each pen the first of January. Once a week these cockerels were shifted from one pen to the other in order to reduce, as much as possible, the influence of the male on the hatchability of the eggs from the different pens.

Beginning January 23 the hens in Pen I received a ten-minute ultra-violet light treatment each day during a period of sixteen weeks. During the period before the light treatment of Pen I was begun, there was no significant difference in the egg production of the two pens. The light treatment had a very marked effect on the egg production which showed up during the first week it was used.

During the sixteen-week period, in which Pen I received the ultra-violet light, the hens laid 497 eggs, while those in Pen II laid only 124 eggs. The eggs in Pen I had about 30 per cent. more calcium in the shell, and 5 per cent. more in the contents (whites and yolks) than the eggs in Pen II. Eggs from Pen I had an average hatchability of 78 per cent.,

while the hatch for those in Pen II was only 40 per cent. The leg weakness and retention of eggs in the oviduct began to be manifested in Pen II about the middle of the sixteen-week period. During the last half of this period six of these hens died. These hens all contained ruptured egg yolk.

On May 12 the light treatment was discontinued on Pen I, and June 1 light treatment was begun on Pen II. When this change was made, the previous record was just reversed. No more hens died in Pen II, and they increased in egg production, while Pen I decreased in egg production. The percentage produced in Lot I fell from 48 per cent. during the sixteen-week light treatment to 23 per cent. during the ten-week period when they received no light treatment. The percentage produced in Pen II increased from 11 per cent. during the sixteen-week period they received no light treatment to 34 per cent. during the ten weeks they received the light. During the period that Pen I received the light treatment, the shells on the eggs weighed 44 per cent. more than those in Pen II. When the light was changed to Pen II the weight of the shells from this pen was 12 per cent. greater than those from Pen I.

These data indicate that the ultra-violet light caused the difference noted between these two pens.

J. S. HUGHES
L. F. PAYNE
KANSAS STATE AGRICULTURAL COLLEGE
MANHATTAN, KANSAS

THE AMERICAN CHEMICAL SOCIETY

DIVISION OF CHEMISTRY OF MEDICINAL PRODUCTS

Executive Committee

E. H. Volweiler, *chairman*, H. A. Shonle, *secretary*, E. B. Carter, F. O. Taylor.

The effect of some guanidine derivatives and other related substances upon the blood sugar of normal rabbits: HARRY E. DUBIN and H. B. CORBITT. In line with Collip's suggestion that insulin might be a guanidine compound, a number of derivatives were tested out for their blood sugar-reducing effect. While a reduction in blood sugar was obtained, it was necessary to use a comparatively large dose. As a result, the animals died; besides, the decrease in blood sugar was not at all comparable to that produced by a unit of insulin. It seems unlikely that insulin is a guanidine compound.

Relationship between chemical structure and physiological action. The effect of 1-suprarenin (synthetic epinephrin) and various derivatives upon the blood sugar of normal rabbits: HARRY E. DUBIN, H. B. CORBITT and LOUIS FREEDMAN. Rabbits were prepared for use in a manner similar to that employed in testing insulin. Definite amounts of 1-suprarenin and various derivatives were injected and the blood sugar noted at stated intervals. The blood sugar-increasing effect varied with the chemical configuration of the substance injected. Frequently, the rise in blood sugar was followed by a decrease below the normal. This is undoubtedly only a compensation for the previous rise and has no further significance.

The establishment of chemotherapeutics: H. M. SPENCER. Chemotherapy has been defined and its limitations enunciated. It has been demonstrated that chemotherapy is a part of physical chemistry rather than of organic chemistry. A new medicament, Mercodel, has been described, the therapeutic vigor of which exemplifies this fact. Chemotherapy should concern itself at least equally with the energy in the body as with the material changes. The limitations of animal experimentation must be recognized, but the value of a comparative study of disease in organic life will lead to most fruitful results. Chemotherapy must contribute to a science of comparative medicine that should shed as much light upon human diseases as comparative morphology has thrown upon an understanding of human evolution.

Mercury derivatives of some carbonyl compounds: EDWARD LYONS. New mercury compounds of several imids and their preparation are described. In these, the mercury joins the molecule through the carbonyl group, and in the case of saccharin, the SO_2 group functions as if 2 CO groups were present. Succinimide and phthalimide yield mono- and di-mercury compounds, saccharin yields mono-, di- and tri-mercury compounds.

The effect of glucose upon the toxicity and therapeutic efficiency of arsphenamine: GEORGE W. RAIZISS, M. SEVERAC and A. KREMENS. In 1917, Kopaczewski suggested the adding of glucose to solutions of arsphenamine in order to prevent immediate reactions, such as nitritoid crises, which sometimes follow the intravenous administration of the drug. It was found by others that glucose generally decreases the toxicity of arsphenamine and its derivatives. It has also been found that solutions of these drugs can be made more or less permanently stable if glucose is added. The authors found that chemical combination takes place between arsphenamine and glucose and they isolated such compounds. These authors further found that the addition of glucose solution decreases the toxicity of arseno compounds, but it diminishes their therapeutic efficiency to still greater extent. The therapeutic efficiency was tested on the albino rat infected with trypanosoma equiperdum.

Studies of the vitamin potency of cod liver oils—XIII—The vitamin A potency of dogfish liver oil: ARTHUR D. HOLMES and MADELEINE G. PIGOTT. Commercial fishermen have raised the question as to the value of dogfish liver oil as a source of the fat-soluble vitamins. To secure information in this connection, dogfish liver oil was prepared from average, mature fish of both sexes. The vitamin A potency of this oil was tested under the same laboratory conditions as employed for testing the vitamin A potency of cod liver oil. It was found that one milligram daily of this dogfish liver oil contained sufficient vitamin A to restore growth and health in albino rats suffering from vitamin A malnutrition.